MASTER IN SOIL STRUCTURES AND SOIL MECHANICS

Main Language of Instruction:
French ☑ English ○ Arabic ○

Campus Where the Program Is Offered: CST

OBJECTIVES

The Master in Structures and Soil Mechanics imparts a sound scientific training in the field of civil engineering. This training offers students the possibility to prepare a dissertation in civil engineering.
The topics concern the civil engineering sector (analysis of structures, behavior of materials, reliability of constructions, geotechnics, geology, soil mechanics and soil dynamics, plates and shells, modeling and calculation by finite elements, Eurocodes, seismic and dynamic calculations, mechanics of structures, soil-structure interaction, etc.).
This Master program aims to form:

- Instructors and researchers
- High-level specialists, essential in the various administrations concerned and design offices
- Foreign researchers: due to the importance of the problems addressed, opening up to foreign students from the Mediterranean basin can bring about a synergy advantageous to better common use of the resource.

PROGRAM LEARNING OUTCOMES (COMPETENCIES)

Students develop a set of skills that prepares them to meet the complex challenges associated with the design, analysis and optimization of structures and foundations:

- Advanced structural design: in-depth understanding of advanced structural design principles, familiarizing the students with international standards and advanced calculation methodologies. This includes the design of complex structures
- Soil analysis: ability to analyze soil properties, evaluate their behavior under different loads and suggest appropriate geotechnical solutions. This includes digital the modeling of soil-structure interactions and geotechnical risk assessment
- Use of nonlinear calculation software: effective use of advanced modeling and simulation software
- Project management: management of resources and skills necessary to plan and execute a project
- Communication techniques: writing of detailed engineering reports, presentation of results in a clear and concise manner, efficient teamwork.

ADMISSION REQUIREMENTS

Candidates are selected following the study of the file provided by the student.

- Admission to the first semester of the Master (MR1) for candidates holding a Bachelor in Physics or an equivalent diploma.
- Admission to the third semester of the Master (MR3) for:
  - Civil engineering graduates
  - Holders of a Master or professional Master in physics
  - Third year civil engineering students at ESIB (fifth year of higher studies)
  - Holders of a recognized equivalent diploma.

The selection of candidates is made by an admission jury within the limits of available places.

COURSES/CREDITS GRANTED BY EQUIVALENCE

Civil engineering graduates, holders of a Master or professional Master in physics, fifth year civil engineering students at ESIB, and holders of a recognized equivalent diploma are granted 60 credits by equivalence: Foundations (5 Cr.). Shear Strength and Slope Stability (4 Cr.). Plates and Shells (4 Cr.). Plastic Behavior of Structures (4 Cr.). Structural Dynamics and Earthquake Engineering (4 Cr.). Dams (4 Cr.). Small Project I (5 Cr.). Strength of Materials (7 Cr.). Fluid Mechanics (7 Cr.). Soil and Rock Mechanics (8 Cr.). Structures (8 Cr.).

PROGRAM REQUIREMENTS

120 credits: Required courses (120 credits)

This Master consists of 120 credits, divided in 4 semesters (MR1, MR2, MR3, and MR4) of around 30 credits each. The preparation of the Master includes:

- Theoretical and practical lessons
- Specialized seminars and conferences
- Technical visits
- A research internship in an approved center and on a dissertation subject.

MR1 (30 Cr.)
Foundations (5 Cr.). Shear Strength and Slope Stability (4 Cr.). Plates and Shells (4 Cr.). Plastic Behavior of Structures (4 Cr.). Structural Dynamics and Earthquake Engineering (4 Cr.). Dams (4 Cr.). Small Project I (5 Cr.).

MR2 (30 Cr.)
Strength of Materials (7 Cr.). Fluid Mechanics (7 Cr.). Soil and Rock Mechanics (8 Cr.). Structures (8 Cr.).

MR3 (30 Cr.)
Behavior of Materials (3 Cr.). Calculation of Anelastic Structures (4 Cr.). Advanced Calculation of Concrete Structures (4 Cr.). Soil Dynamics (4 Cr.). Engineering Seismology (3 Cr.). Advanced Calculation of Steel Structures (3 Cr.). Advanced Statistics and Operational Research (3 Cr.). Design and Reliability of Structures (3 Cr.). Advanced Modeling of Materials and Structures (3 Cr.).

MR4 (30 Cr.)
Research Internship and Dissertation (30 Cr.).

SUGGESTED STUDY PLAN

Semester 1

Code	Course Name	Credits
020FOSMM1	Foundations	5
020CISMM1	Shear Strength and Slope Stability	4
020PLCMM1	Plates and Shells	4
020PLSMM1	Plastic Behavior of Structures	4
020DYNMM1	Structural Dynamics and Earthquake Engineering	4
020BARMM1	Dams	4
020SM1MM1	Small Project I	5
	Total	**30**

Semester 2

Code	Course Name	Credits
020RDMMM2	Strength of Materials	7
020MEFMM2	Fluid Mechanics	7
020MESMM2	Soil and Rock Mechanics	8
020STRMM2	Structures	8
	Total	**30**

Semester 3

Code	Course Name	Credits
020COMMM3	Behavior of Materials	3
020CSAMM3	Calculation of Anelastic Structures	4
020EC2MM3	Advanced Calculation of Concrete Structures	4
020DYSMM3	Soil Dynamics	4
020SISMM3	Engineering Seismology	3
020EC3MM3	Advanced Calculation of Steel Structures	3
020SROMM3	Advanced Statistics and Operational Research	3
020CFOMM3	Work Design and Reliability	3
020MMSMM3	Advanced Modeling of Materials and Structures	3
	Total	**30**

Semester 4

Code	Course Name	Credits
020MSMMM4	Research Internship and Dissertation	30
	Total	**30**

COURSE DESCRIPTION

a- Semesters MR1 and MR2

020FOSMM1 Foundations 5 Cr.

Geotechnical properties of soils. Geotechnical investigation. Bearing capacity and settlement of foundations. Shallow foundations. Raft. Retaining walls. Sheet pile walls and slurry walls. Deep foundations. Foundations on difficult soils. Soil improvement.

020CISMM1 Shear Strength and Slope Stability 4 Cr.

Reminder of the theory of stress and failure criteria. Evaluation of shear strength. Shear strength of sandy soils. Shear resistance of clayey soils. Cyclic shear strength. Introduction to constitutive models. Calculation of slope stability. Remediation of instability issues.

020PLCMM1 Plates and Shells 4 Cr.

Generalities and description of thin-walled elements. Flexion of circular and rectangular plates. Simplified theory of shells of any shape. Shells of revolution. Variational formulation of plate and shell problems. Geometry of surfaces.

020PLSMM1 Plastic Behavior of Structures 4 Cr.

Plasticity criteria. Structures in the plastic field. Plastic hinge. Step by step calculation.

020DYNMM1 Structural Dynamics and Earthquake Engineering 4 Cr.

Simple oscillator. Multiple oscillator. Response of a structure to an earthquake. Calculation from an accelerogram. Calculation from a response spectrum. Regulatory aspects. Modeling of structures. Seismic design. PS92 Rules.

020BARMM1 Dams 4 Cr.

Characteristics of soils and slopes. Design of flexible dams. Creation of artificial reservoirs. Embankment dams and appurtenant structures. Hydraulic concrete structures. Diversion dams. Channel design.

020SM1MM1 Small Project I 5 Cr.

Carry out a small project in one of the subjects of this semester.

020RDMMM2 Shear Strength 7 Cr.

Beam theory. Normal load. Flexion. Torsion. Shear force. Calculation of the critical load of a structure: Theory of Euler, Dutheil. Energy theorems: Clapeyron, Maxwell-Betti reciprocity, virtual works, Castigliano, Menabrea. Method of three moments. Foci method. Section cut method. Elastic center method. Laboratory: Compression test on concrete cylinder + ultrasound, extensometers, torsion, traction on steel bar.

020MEFMM2 Fluid Mechanics 7 Cr.

Concepts and properties of fluids. General principles of kinematics. Stress Theory. Statics of incompressible and compressible fluids. Conservation of mass and continuity equation. Application to the case of ideal fluids. Vorticity kinematics. Potential planar flows. Flow regimes and application to laminar and turbulent flows. Introduction to the boundary layer. Dimensional analysis and similarity. Numerical approach. Practical work: Nozzles, flow analysis by rheoelectric analogy, Poiseuille flows, verification of Bernoulli's principle, flow in a hydrodynamic tunnel, viscosity measurement, analysis of jets on plates and study of flow regimes.

020MESMM2 Soil and Rock Mechanics 8 Cr.

Generalities. Properties and classification of soils. Clay minerals. Compaction and road geotechnics. Water in soil. Permeability, flow and effective stress. Consolidation and settlements. Consolidation speed. Mohr's circle and soil failure theories. Introduction to rock mechanical properties. Environmental geotechnics. Laboratory: sieve analysis, Hydrometer analysis, Atterberg limits, shear test, Proctor compaction test, oedometer consolidation test.

020STRMM2 Structures 8 Cr.

Study and use of influence lines and their application. Study of arches. Rotation method. Hardy Cross method. Computer calculation of structures. Beams on elastic support. Beams on elastic soil. Displacement method. Fully intrinsic equations. Solicitations. Deformations. Study of the structure stability. Use of structural calculation software.

b- Semesters MR3 and MR4

020COMMM3 Behavior of Materials 3 Cr.

Deformation and kinematics. Conservation law. Virtual work. Constitutive equation. Thermo-mechanics.

020CSAMM3 Calculation of Anelastic Structures 4 Cr.

Step by step method. Static theorem. Kinematic theorem. Regulatory aspect. Optimization.

020EC2MM3 Advanced Calculation of Concrete Structures 4 Cr.

Reinforcement optimization calculation. Limited redistribution of moments (comparison of methods). Design of reinforced concrete structural systems and their members according to EC2. Advanced torsion calculation. Reinforcement in seismic calculation (with comparison between different codes).

020DYSMM3 Soil Dynamics 4 Cr.

Introduction to seismic geotechnics. Characterization of seismic movements. Laboratory and field site methods. Cyclic behavior of granular and clay soils. Liquefaction. Dynamic response calculation.

020SISMM3 Engineering Seismology 3 Cr.

Seismic hazard. Seismic risk. Zoning.

020EC3MM3	**Advanced Calculation of Steel Structures**	**3 Cr.**

Calculation basis for Eurocodes 3 and 4. Calculation of assemblies. Mixed calculation of slabs. Mixed calculation of columns.

020CFOMM3	**Design and Reliability of Structures**	**3 Cr.**

Reliability theory. Structural performance. Potential design risks. Capacity factor. Evaluation of the different variables that affect the design.

020SROMM3	**Advanced Statistics and Operational Research**	**3 Cr.**

Decision analysis. Simulations. Markov decision process. Response surface methodology. Regression analysis. Stochastic process.

020MMSMM3	**Advanced Modeling of Materials and Structures**	**3 Cr.**

Advanced nonlinear structural calculation. GMNIA. MNA. LBA.

020MSMMM4	**Research Internship and Dissertation**	**30 Cr.**

This course constitutes an introduction to research techniques. It is the synthesis of four months of research in a research center or laboratory.